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Abstract

CHEMONUCLEAR PROCESSES

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A chemonuclear reactor is defined as a nuclear reactor that makes direct use of a significant fraction of the energy of fission, either as the kinetic energy of the fission fragments, or as the kinetic energy of neutrons, betas and gammas associated with fission, to break chemical bonds and form a chemical product. A chemonuclear plant would consist of (1) a nuclear island which contains the equipment in which the chemical bonds are broken and the desired products are formed; (2) a radiochemical island in which the product and side products, if any, are separated from the primary reactant fluid and radioactivity is removed from the product; (3) a conventional chemical island which contains equipment for handling the non-contaminated inputs and outputs of the plant; and (4) a turbine island to generate by-product electricity, if the plant is a dual-purpose one.

Cost analyses have been made of nine different chemical products, and data generated to indicate the economic potential of the processes. The present status of chemonuclear research is illustrated by a review of the chemistry and technology of two processes -- the fixation of nitrogen and the production of hydrazine.

Gamma-ray capsule data, fission-fragment capsule data, and fission-fragment loop data are presented for the yield and steady-state concentration of NO_2 in the radiolysis of N_2/O_2 mixtures at a variety of temperatures and pressures, and also for the yield and steady-state concentration of N_2H_4 in the radiolysis of liquid NH_3.

An analysis has been made of the accuracy of the fission-fragment data obtained thus far. Problems of fission-fragment dosimetry and energy-deposition efficiency have been investigated. Fission-fragment sources for research and for potential fission-fragment reactor fuels have been studied, as have characteristics (including radiation damage and chemical corrosion) of U-bearing glass fibers, UO_2 particles and experimental fission-fragment sources using U/Al foil, U/Pd foil and UO_2 particles. Foil fuel elements for fixed-fuel gaseous chemonuclear reactors have been described. Experience with fine particulate UO_2/liquid-NH_3 slurries has been obtained.

Descriptions are given of the operating RPI gas loop, the operating AGN hydrazine loop, and the proposed BNL gas loop.